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Observation of Momentum-Confined In-Gap Impurity State in $Ba_{0.6}K_{0.4}Fe_2As_2$: Evidence for Antiphase s+- Pairing PENG ZHANG, PIERRE RICHARD, TIAN QIAN, XUN SHI, JUN MA, LINGKUN ZENG, XIAOPING WANG, Beijing National Laboratory for Condensed Matter Physics, and Institute of Physics, Chinese Academy of Sciences, EMILE RIENKS, Helmholtz-Zentrum Berlin, BESSY, CHENGLIN ZHANG, Department of Physics and Astronomy, Rice University, PENGCHENG DAI, Beijing National Laboratory for Condensed Matter Physics, and Institute of Physics, Chinese Academy of Sciences, YIZHUANG YOU, ZHENGYU WENG, Institute for Advanced Study, Tsinguha University, XIANXIN WU, JIANGPING HU, HONG DING, Beijing National Laboratory for Condensed Matter Physics, and Institute of Physics, Chinese Academy of Sciences — We report the observation by angle-resolved photoemission spectroscopy of an impurity state located inside the superconducting gap of $Ba_{0.6}K_{0.4}Fe_2As_2$ and vanishing above the superconducting critical temperature, for which the spectral weight is confined in momentum space near the Fermi wave-vector positions. We demonstrate, supported by theoretical simulations, that this in-gap state originates from weak scattering between bands with opposite sign of the superconducting-gap phase. This weak scattering, likely due to off-plane nonmagnetic (Ba, K) disorder, occurs mostly among neighboring Fermi surfaces, suggesting that the superconducting-gap phase changes sign within holelike (and electronlike) bands. Our results impose severe restrictions on the models promoted to explain high-temperature superconductivity in these materials.

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